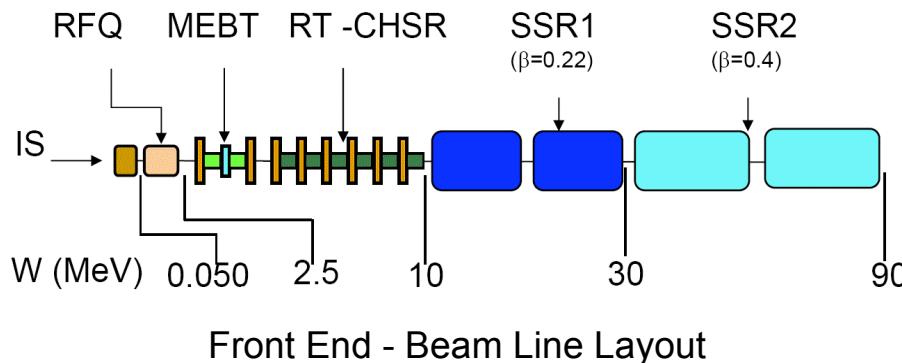
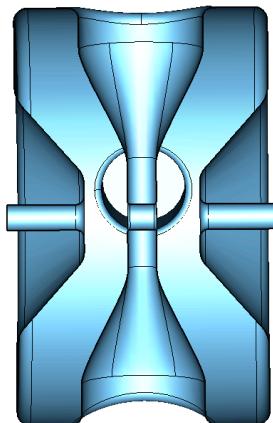
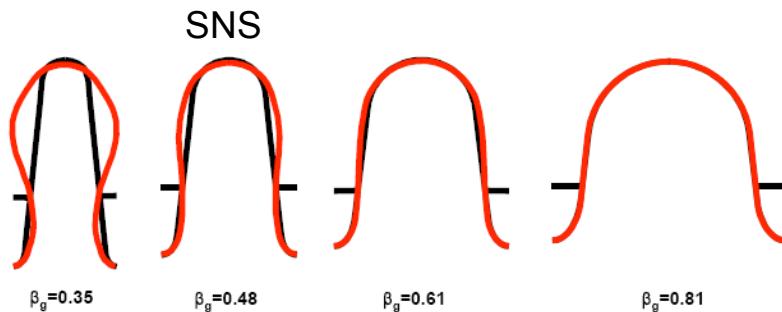


# Superconducting spoke cavities

I. Gonin & G. Lanfranco



Deformed and origin shapes of elliptical cavity due to static Lorentz force at  $E_0 T = 10 \text{ MV/m}$  (805 MHz), 50000 scale.



MWS solid model

### SSR1 section ( $0.15 < \beta < 0.26$ ) 18 resonators, 18 SC Solenoids

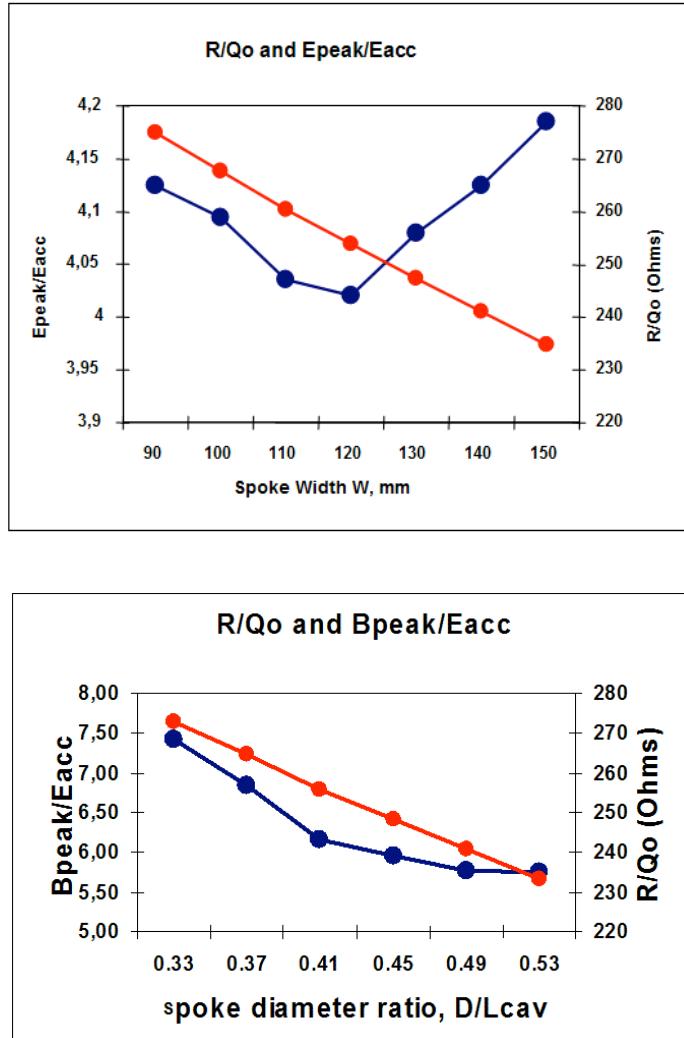
RF&Mechanical Design

2 prototypes under production in Europe (Zanon) and USA (Roark)

### SSR2 ( $0.26 < \beta < 0.47$ ) 22 resonators , 22 SC Solenoids

RF Design

# RF DESIGN OF SSR at $\beta = 0.22$



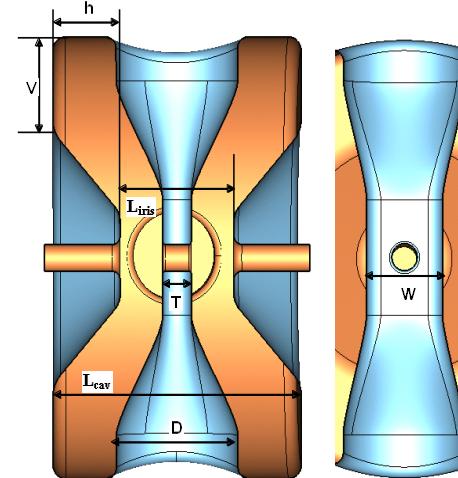
Beam dynamic simulation led us to chose:

$$F = 325\text{MHz}$$

$$R_{\text{aperture}} = 15\text{mm}$$

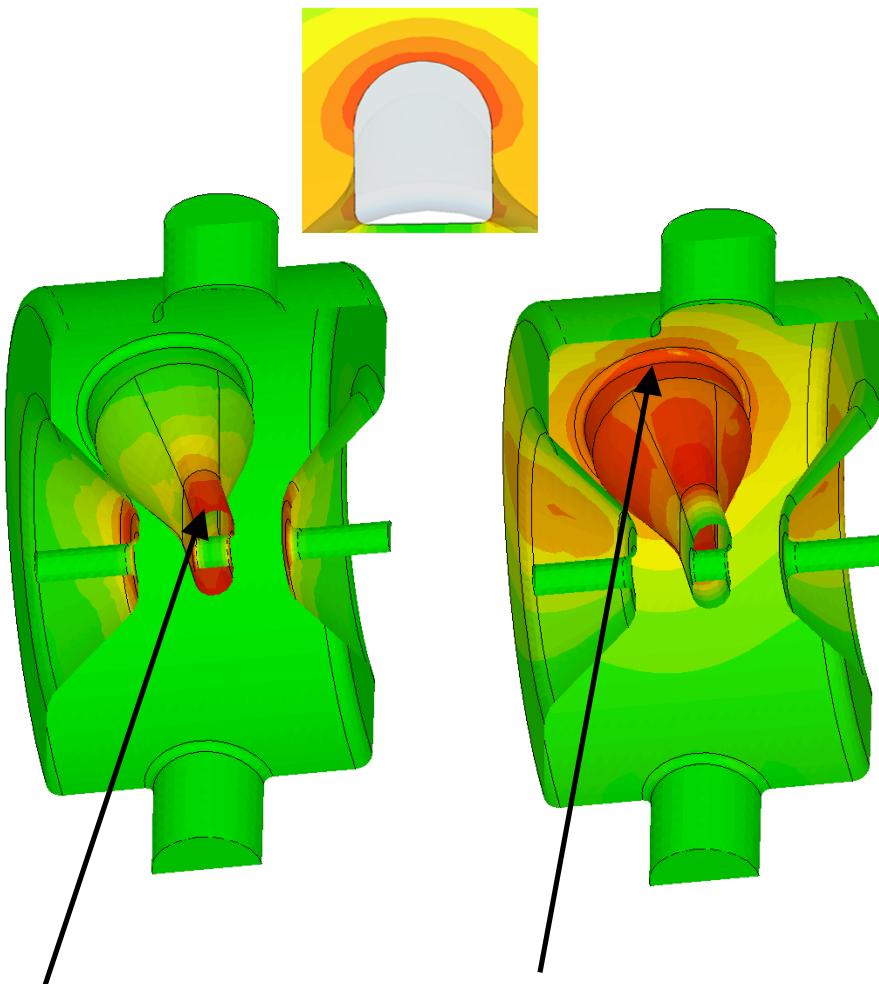
$$E_{\text{acc}} \sim 10\text{MV/m}$$

The goal of Design is minimization of  $E_{\text{peak}}/E_{\text{acc}}$  and  $B_{\text{peak}}/E_{\text{acc}}$



Cross-section of SSR with main parameters used in optimization process.  $L_{\text{cav}}$  – cavity length,  $L_{\text{iris}}$  – iris to iris length,  $D$  – spoke diameter,  $W$  – spoke width,  $T$  – spoke thickness,  $h$  and  $v$  – dimensions of end cup.

# RF DESIGN OF SSR at $\beta = 0.22$



$E_{\text{peak}}/E_{\text{acc}}$

$B_{\text{peak}}/E_{\text{acc}}$

	SSR1	SSR2	TSR
Operating Temperature	4.2 K		
Duty Cycle	1 %		
Accelerating Gradient	$\sim 10$ MV/m		
Quality Factor at Design Gradient	$> \sim 10^9$		
Beam Pipe ID [mm]	30	30	40
Input Power [kW]	35	85	220
LFD Coefficient Hz/(MV/m) <sup>2</sup>	3.8	-	-
Beta	0.22	0.4	0.62
$E_{\text{PEAK}}/E_{\text{ACC}}$	2.55	2.28	3.22
$B_{\text{PEAK}}/E_{\text{ACC}}$ [mT/(MV/m)]	4.87	4.37	6.85
$R/Q_0(\Omega)$	242	310	562
$G(\Omega)$	84	112	116

The effective length  $L_{\text{effective}}$  is assumed equal to the iris to iris length and for SSR1 and SSR2 is  $2/3\beta l$  while for TSR is  $5/3\beta l$ .  $R$  [W] being the shunt impedance,  $Q_0$  the quality factor,  $G$  [W] the geometrical factor.

## RF DESIGN OF SSR at $\beta = 0.22$

	<b>When</b>	<b><math>f_0</math></b>	<b><math>\beta</math></b>	<b>Gaps</b>	<b>Radius</b>	<b>Length</b>	<b>Aperture</b>	<b><math>E_p/E_a</math></b>	<b><math>B_p/E_a</math></b>	<b>G</b>
		MHz			cm	cm	cm		mT/MV/m	$\Omega$
ANL	1998	340	0.300	2	22.0	17.7	1.3	4.20	9.100	71
	1998	340	0.400	2	22.0	22.2	1.3	4.00	10.700	75
CNRS	2002	359	0.350	2	20.4	15.0	3.0	3.06	8.280	101
LANL	2002	350	0.175	2	19.6	10.0	2.5	2.82	7.380	85
FNAL	2005	325	0.22	2	23.0	13.5	1.5	2.55	4.87	87

# Cavity Manufacturing (Zanon)

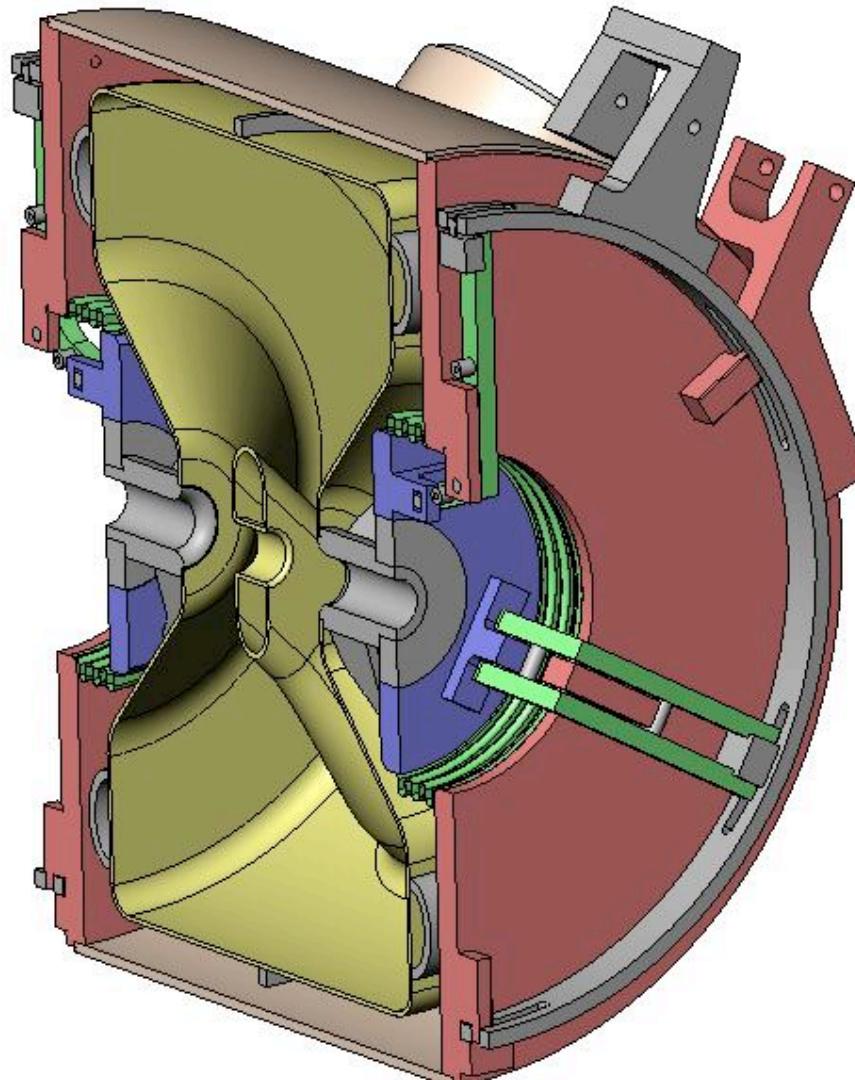


# Cavity Manufacturing (Roark)



# Double Cavity Slow Tuning

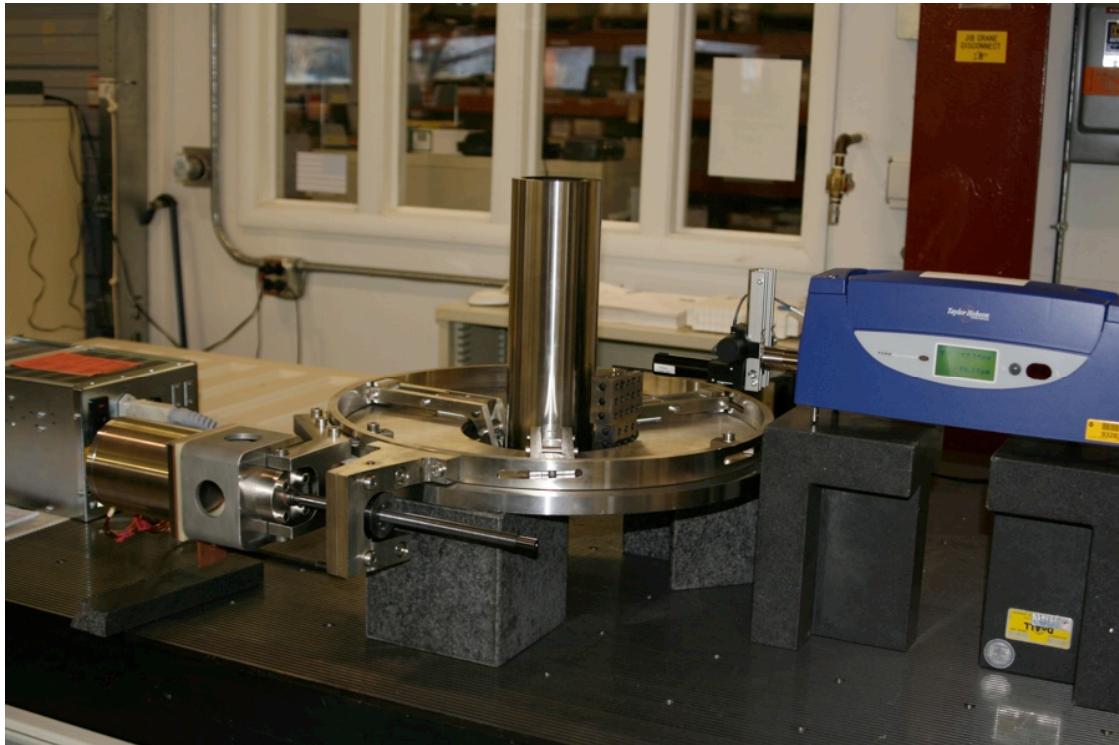
1. Redundant system (two stepper motors, tuning system cost relatively low)
2. Robust cavity support
3. Symmetric configuration, hence symmetric iris gaps
4. Inelastic tuning possible
5. Power coupler supported by helium vessel, no load on cavity
6. No bellows at power coupler port, hence less  $\Delta F$  due to vacuum pressure and more compact design.





SSR1 Slow Tuner prototype





SSR1 Slow Tuner prototype  
TESTING



<b>STEPS</b>	<b>microns</b>	<b>STEPS</b>	<b>microns</b>
-1000	-2.5	10000	22.1
-2000	-4.2	20000	48
-3000	-7.1	30000	74
-4000	-9.2	50000	127.1
-5000	-12.3	60000	154.1
-6000	-14.8	75000	194.7
-7000	-17.3	50000	130.9
-8000	-19.7	25000	65.2
-9000	-22.6	10000	26.9
-10000	-24.9	0	-0.1
-12000	-30.8	-25000	-67.3
-14000	-35.2	-50000	-130.6
-16000	-40.9	-75000	-196.4
-18000	-46.4	-25000	-68.6
-20000	-50.9	0	-4.6
-25000	-64.4	25000	61.7
-30000	-77.6	0	0.2
-35000	-90.7	50000	128.5
-40000	-103.6	90000	233.9
-50000	-130.3	0	0.2
-30000	-82.8		
-10000	-30		
0	-3.6		

# Slow Tuner test results

negative values bring the cavity inward, positive values outward

